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Another Way of Contribution to the World Peace by Physicists

... “Detector Technology” applied at International Organization

J. Tanaka
Equipment Officer
On-Site Inspection Div.
Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)
Junichi.Tanaka@ctbto.org

Contents

- International organizations which need ”Detector Technology”
  - International Atomic Energy Agency
  - Comprehensive Nuclear-Test-Ban Treaty Organization
- New “Detector Technology” at International Organization
  - Nuclear material safeguards by means of neutrino measurements
  - Radioactive noble gas measurements for nuclear test detections

International Organizations

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... Organizations (to be) under United Nations frame work (or others),

such as... *(for physicists)*

- International Atomic Energy Agency (IAEA)
- Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)
- ITER Organization
- OECD – Nuclear Energy Agency

……

IAEA

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International Atomic Energy Agency

- UN organization of nuclear field… ***" Atom for Peace"***

- **Safeguards**
  - Nuclear material safeguards, or "Inspections"
  - Development and technical support for the operations

- **Nuclear Energy**
  - Knowledge center of nuclear power (energy) techniques, or applications

- **Nuclear Safety and Security**
  - International center of nuclear (power plant) safety
  - Prevention for "nuclear terrorism"

IAEA *(cont'd)*

- **Nuclear Sciences and Applications**

  Promotion of nuclear application, such as:

  - Human health
  - Physics and Chemical application (Databank)
  - Agriculture
  - Marine Environment …

- **Technical Cooperation**

  Help developing countries for nuclear technology transfer

  - Human health
  - Agriculture
  - Nuclear material management, radiation safety
  - Nuclear science ...

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Preparatory Commission of Comprehensive Nuclear-Test-Ban Treaty Organization

- Enforce "*Comprehensive Nuclear-Test-Ban Treaty*"
- Monitor *possible* nuclear weapon test

- **International Monitoring System (IMS)**
  - Monitor evidences of nuclear weapon tests 24/7
  - Seismic, Radionuclide (particulate, gas), Ultrasound…

- **International Data Center**
  - Data analysis of IMS data

- **On-site Inspection**
  - Inspections in the field in case (suspicious) nuclear tests detected.

Detectors at IAEA (1)

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Safeguard inspection

Nuclear material (U and Pu) control by means of…

- Seals and containment
- Surveillance cameras
- Record accountancy
- "**Non Distractive Assays**" (NDA)

  e.g. γ or neutron measurements

Detectors at IAEA (2)

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Non-Destructive Assay

- γ (185keV ^{235}U) measurements for U enrichments
  Ge, NaI, CdZnTe… + MCA + PC/SW
- Neutron coincidence counting for U and Pu meas.
  ~ 2 neutrons produced by a fission
  ^{3}He counters + shift register
- Numerical calculations, Monte Carlo simulations

  System design, estimation of counting rate etc.

Detectors at IAEA (3)

Detectors at CTBTO (1)

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- **International Monitoring System (IMS)**
  - Automated monitor for
    - Radioactive particulates (fission products :air filter)
    - Radioactive gasses ($^{131m, 133, 133m, 135}$Xe)

- **On-site Inspection**

  - Gross gamma survey (aerial, ground)
  - Environmental sampling (vegetation, soil, water…) and isotope identifications (by γ spectrometry)
  - Gas sampling and β–γ analysis (^{37}Ar, $^{131m, 133, 133m, 135}$Xe)

IMS Network

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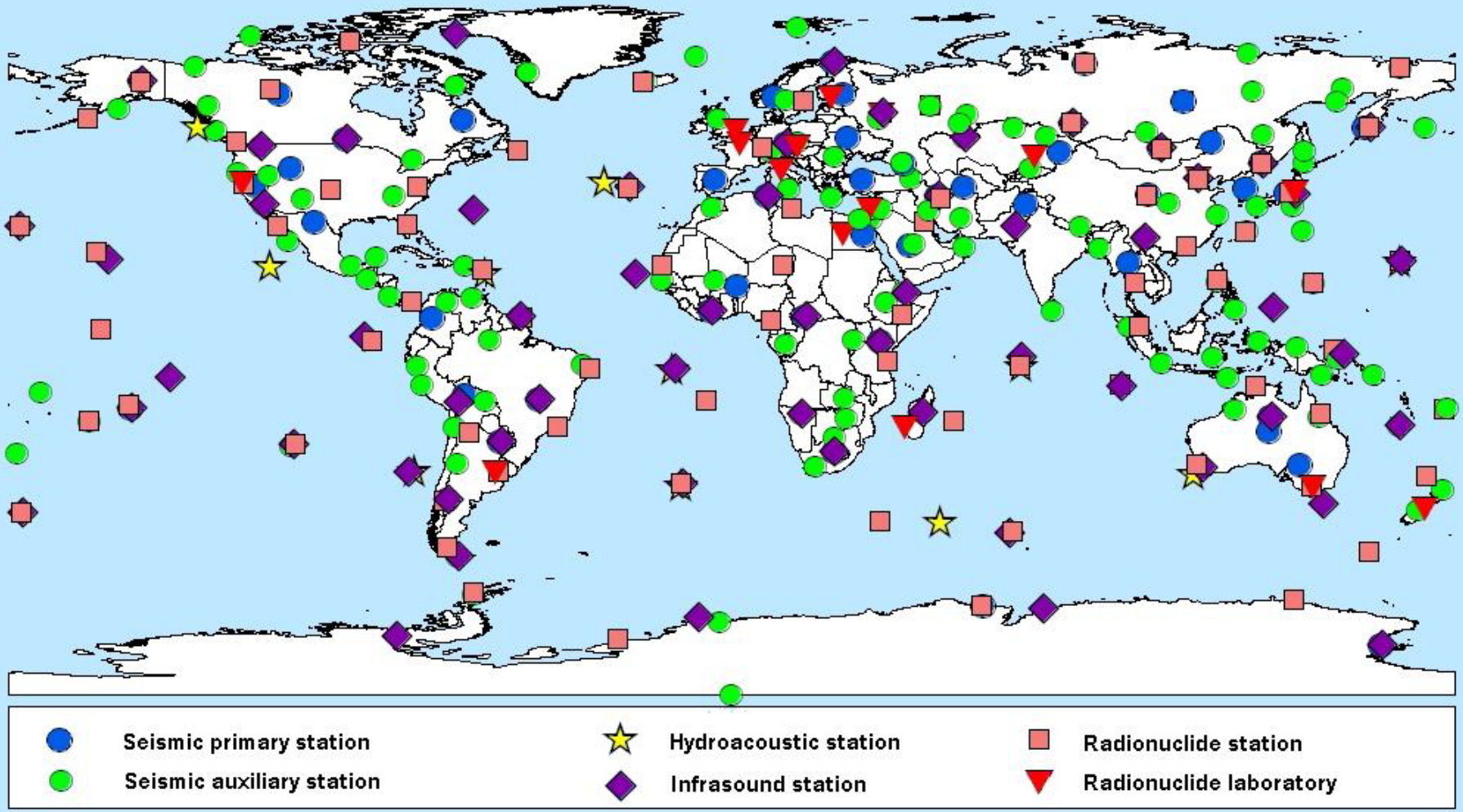

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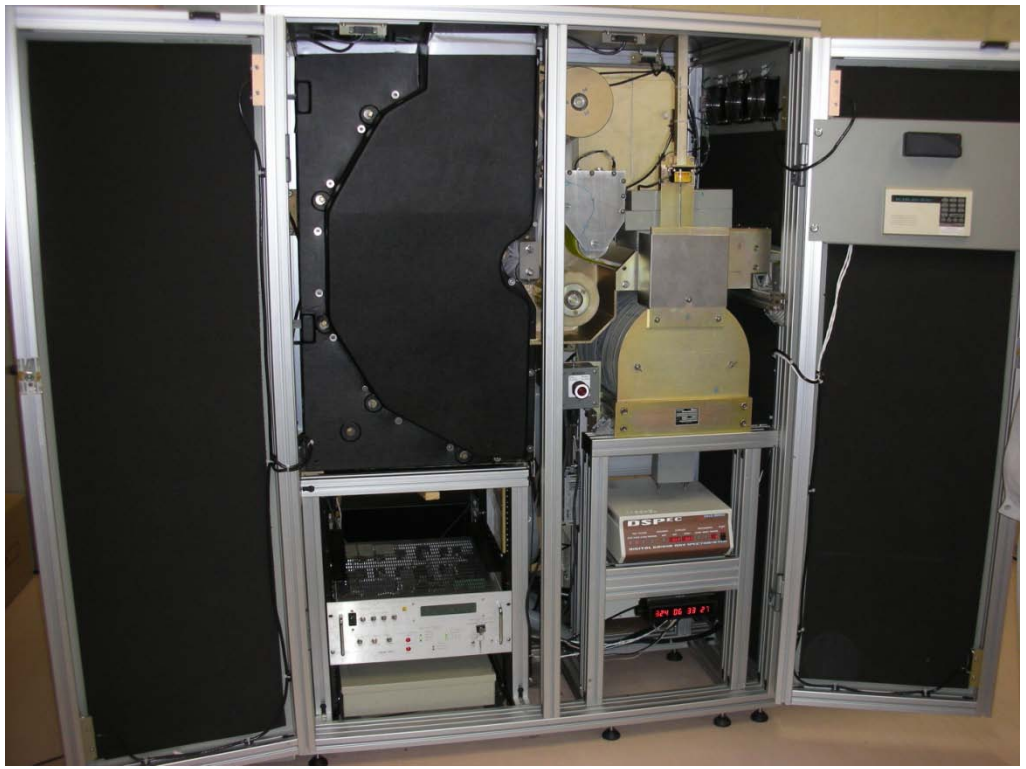
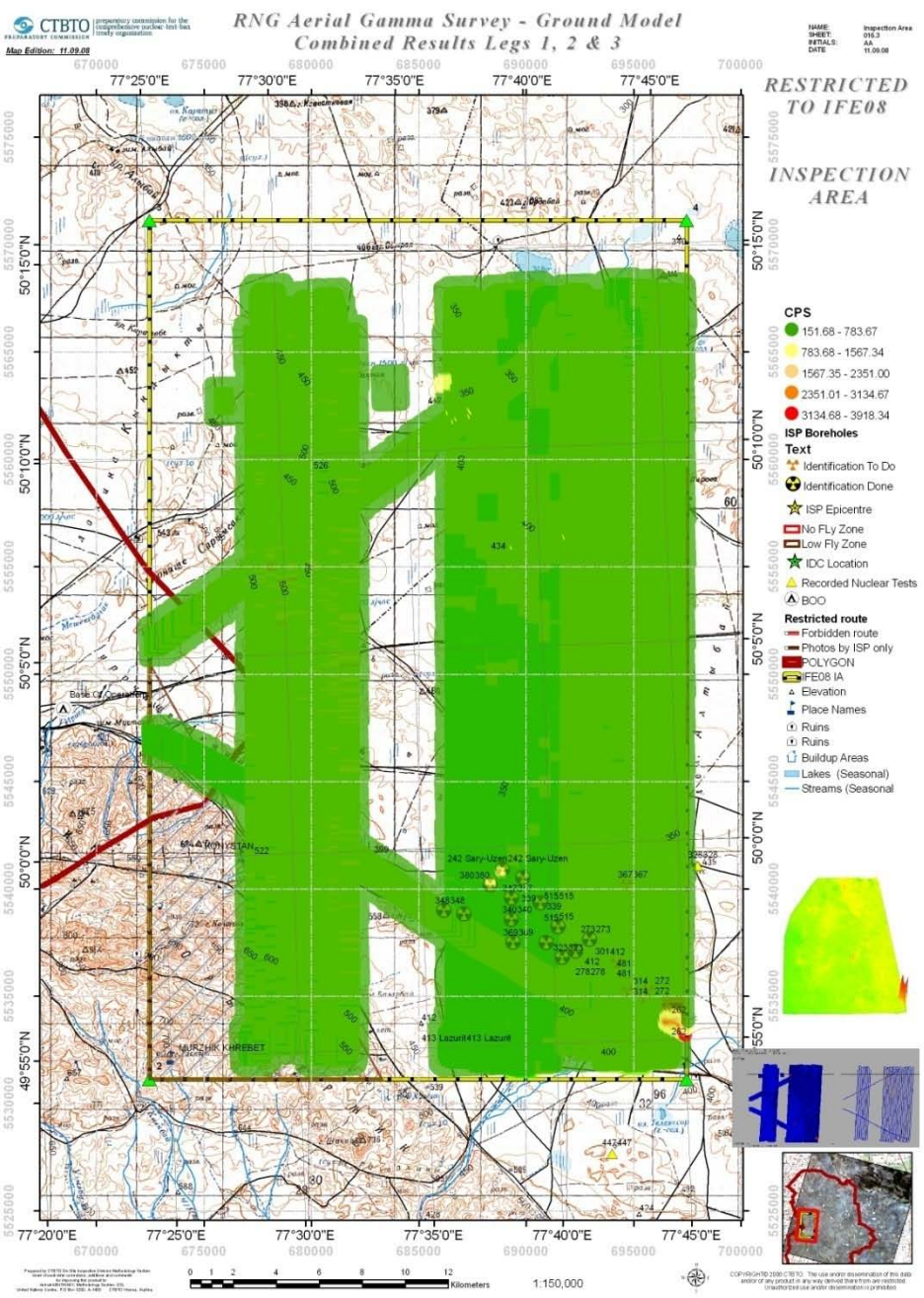
OMMISSION





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500m


SAUNA
SAUNA

New technical developments

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Neutrino detections for nuclear safeguards

… Qualitative verifications of “no-change” of nuclear fuels.

e.g. U enrichment, Pu contents, etc.

Studied by

SUBATECH/CEA + (NUCIFER/DCHOOZE)

Sandia/LLNL

Niigata + (KASKA)

New technical developments

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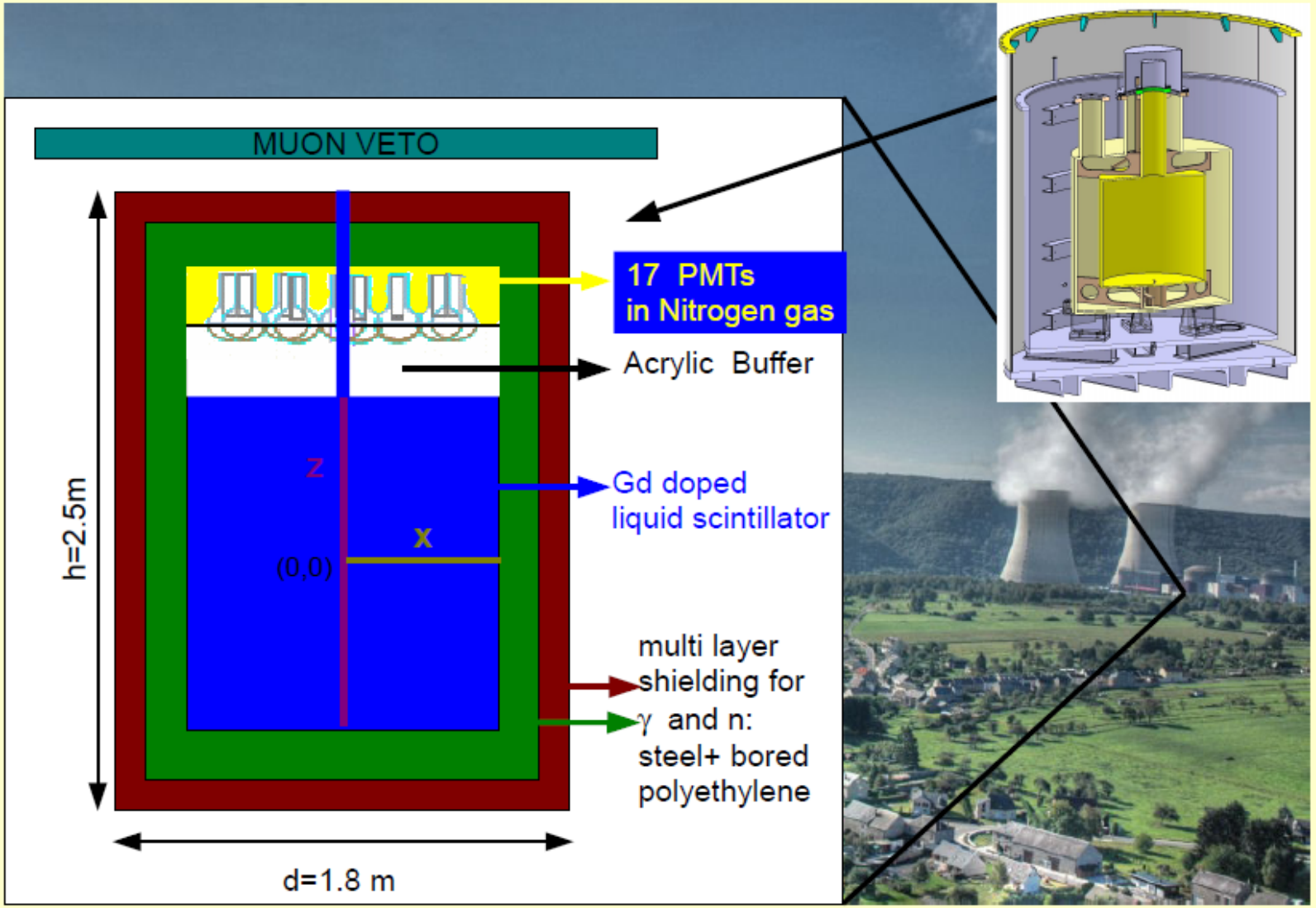
The Nucifer detector: idea of a mini Double Chooz



New technical developments

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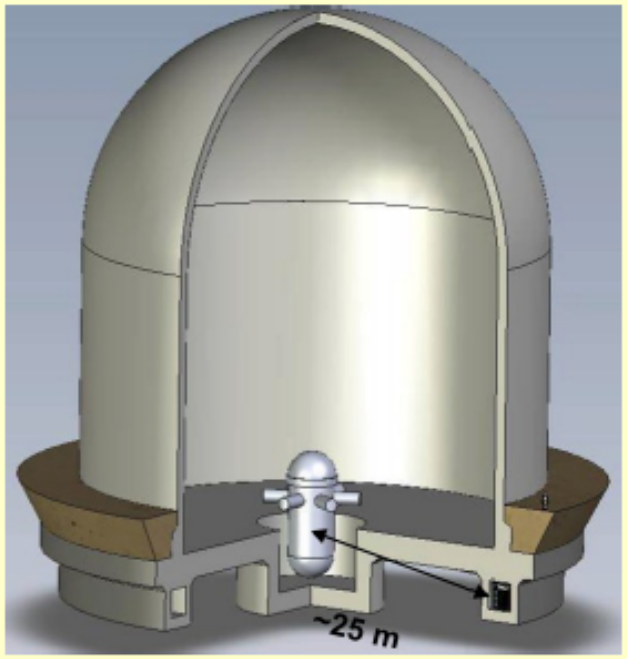
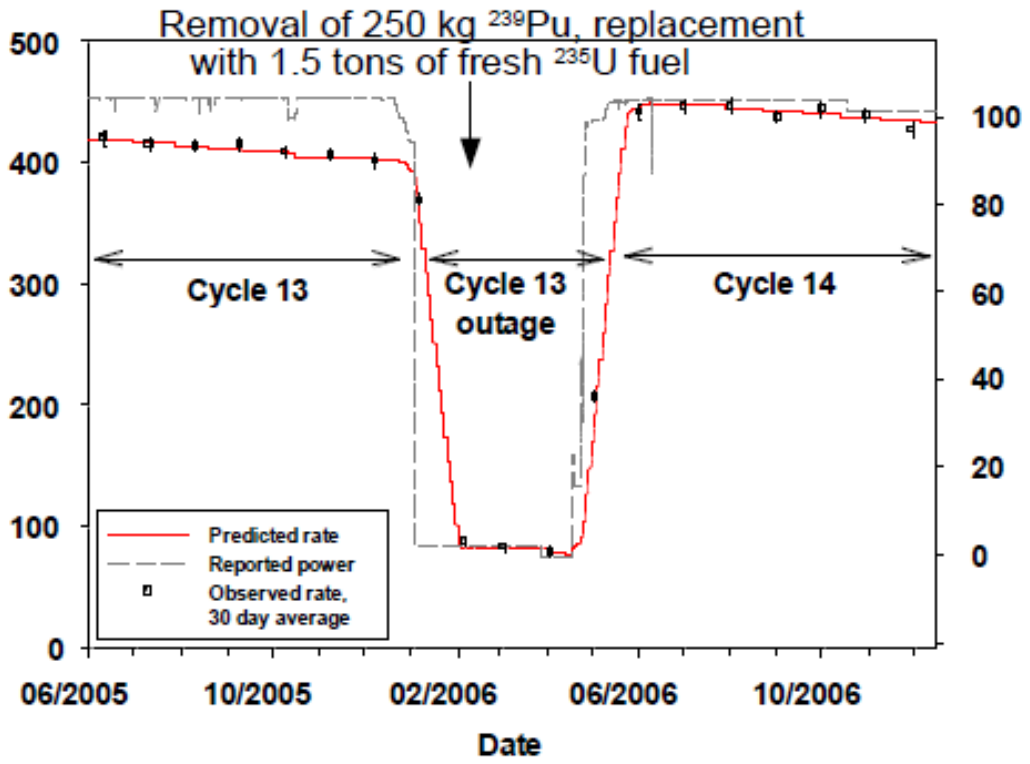
LLNL/SANDIA detector results:



- 1.1 GW_{el} → ~10^{21} ν/s
- 3800 int. expected per day in 1m³ liq. scint. target with ε_{det} = *100%*

LLNL/Sandia Antineutrino Detector, Bowden @ AAP 2007



New technical developments

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Neutrino detections for nuclear safeguards

- Power monitor of reactor
- Fuel composition: U/Pu rate, diversion

Main characteristics of antineutrinos originating from ^{235}U, ^{238}U, ^{239}Pu and ^{241}Pu fission, in standard PWR

	^{235}U	^{238}U	^{239}Pu	^{241}Pu
Released energy per fission (MeV)	201.7	205.0	210.0	212.4
Mean energy of antineutrinos (MeV)	1.46	1.56	1.32	1.44
Number of antineutrinos per fission (E>1.8 MeV)	5.58 (1.92)	6.69 (2.38)	5.09 (1.45)	5.89 (1.83)

New technical developments

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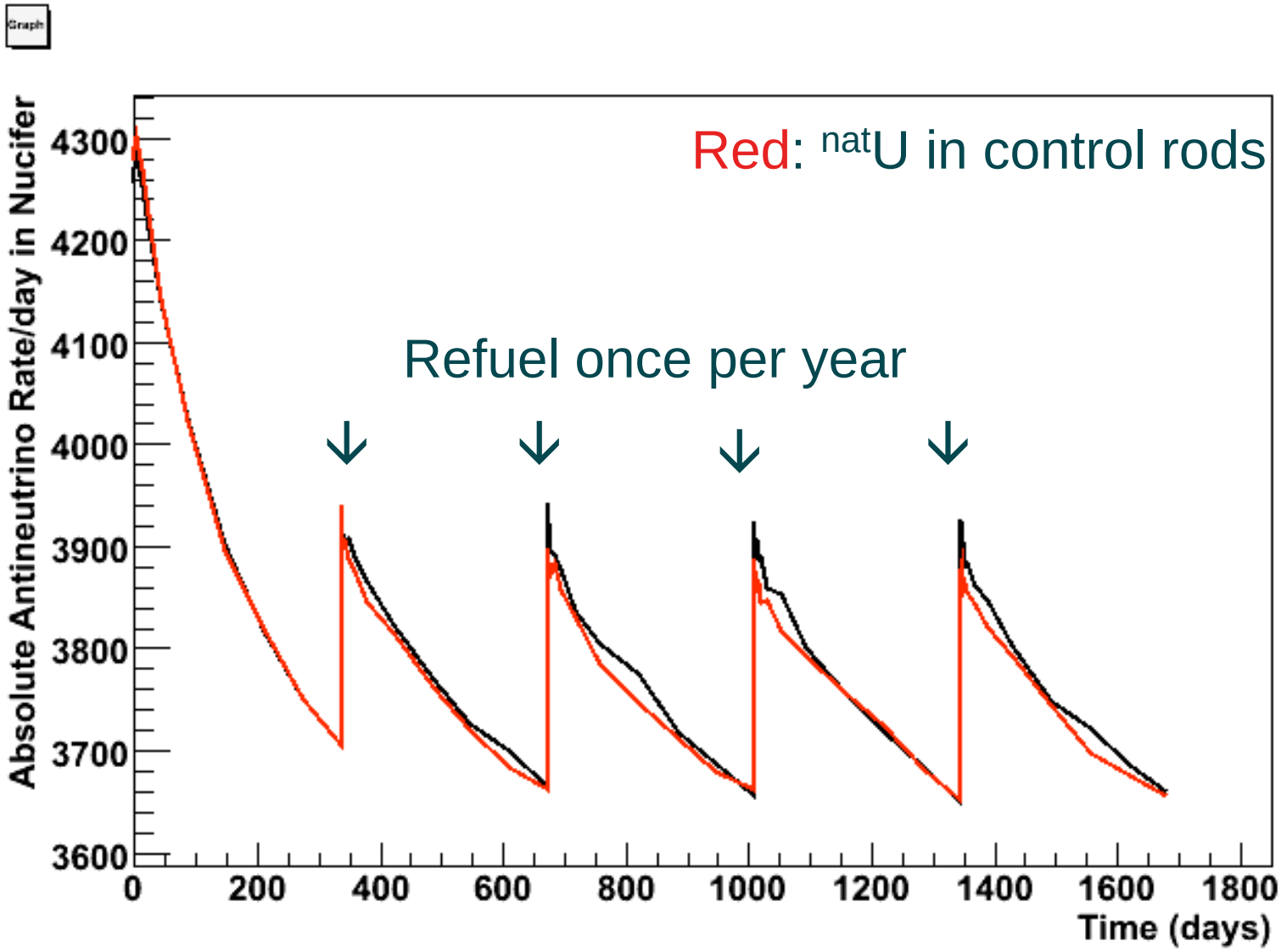

New technical developments

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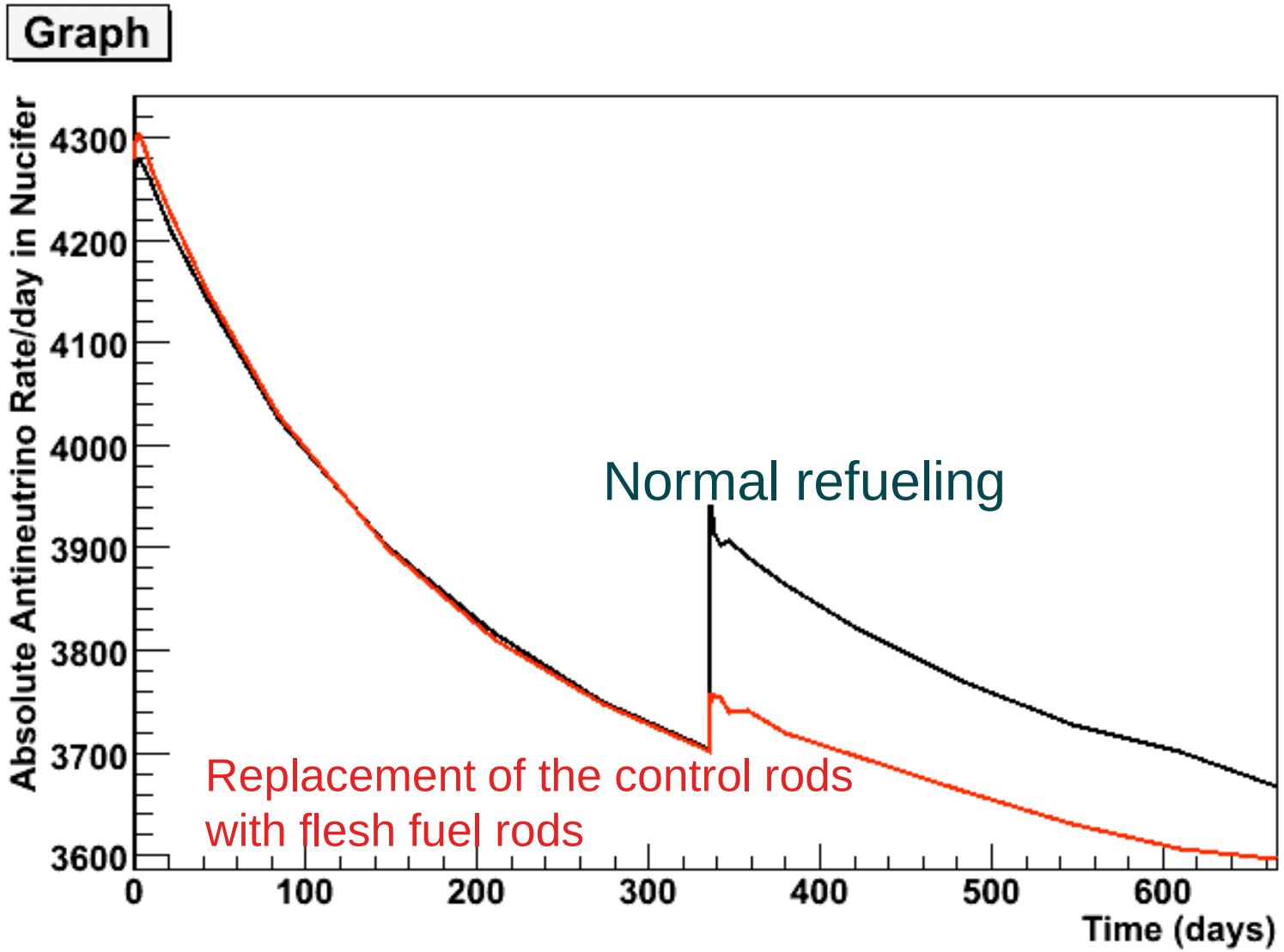

Developments at CTBTO

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"Noble gas" (^{37}Ar, $^{131m, 133, 133m, 135}$Xe) detection for nuclear explosion monitoring

Gases will be only radioactivities to be released from underground explosions

- $^{131m, 133, 133m, 135}$Xe … fission products
- ^{37}Ar … ^{40}Ca(n, α) ^{37}Ar

- Gas purification + β–γ (or high res γ, x-ray)
- Seeping mechanism, when and where to sample.
- Sampling technique of underground gas
- Background study, natural and artificial, atmospheric transfer modeling …

Developments at CTBTO

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^{131m}Xe IT $_{(164keV)}$, $K_{x(30keV)}$

^{133}Xe $\beta + \gamma_{(81keV)}$

^{133m}Xe IT $_{(233keV)}$, $K_{x(30keV)}$

^{135}Xe $\beta + \gamma_{(250keV)}$

→ β–γ (PL +NaI) or high res γ (Ge)

^{37}Ar EC, $K_{x(2.38keV)}$

→ Proportional chamber for K_x

Developments at CTBTO

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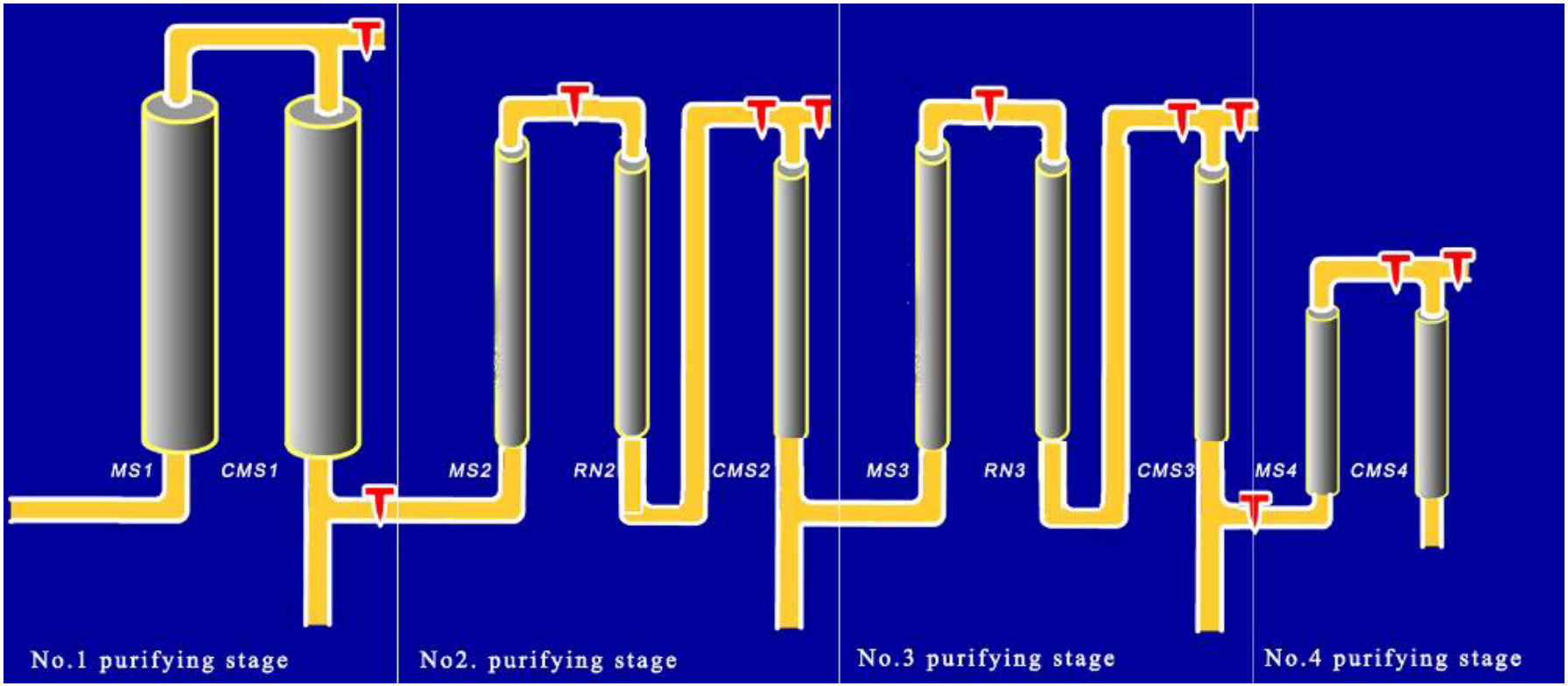
Gas purification



Purification by thermal swing.
(adsorb at low temperature and to desorb at nearly 300℃.)

Developments at CTBTO

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Xe system

Developments at CTBTO

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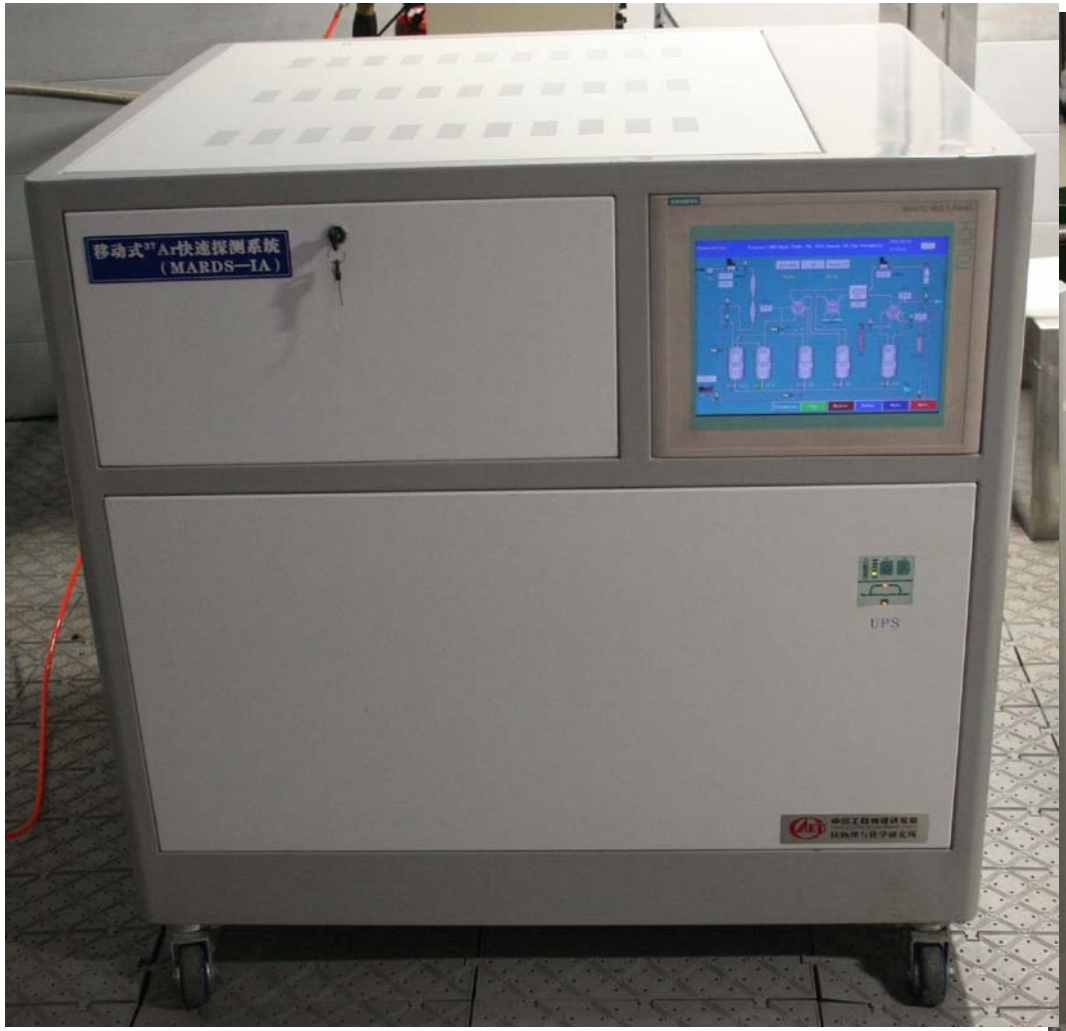
Ar system



New technical developments (2)

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^{rad}Xe Background

Atmospheric air: Release from reactors (medical isotopes, power plant)

Underground : Natural uranium fissions

^{37}Ar Background: Underground ^{40}Ca hit by cosmic ray

… ^{rad}Xe background trace and back track by atmospheric transfer modeling

DPRK 2006

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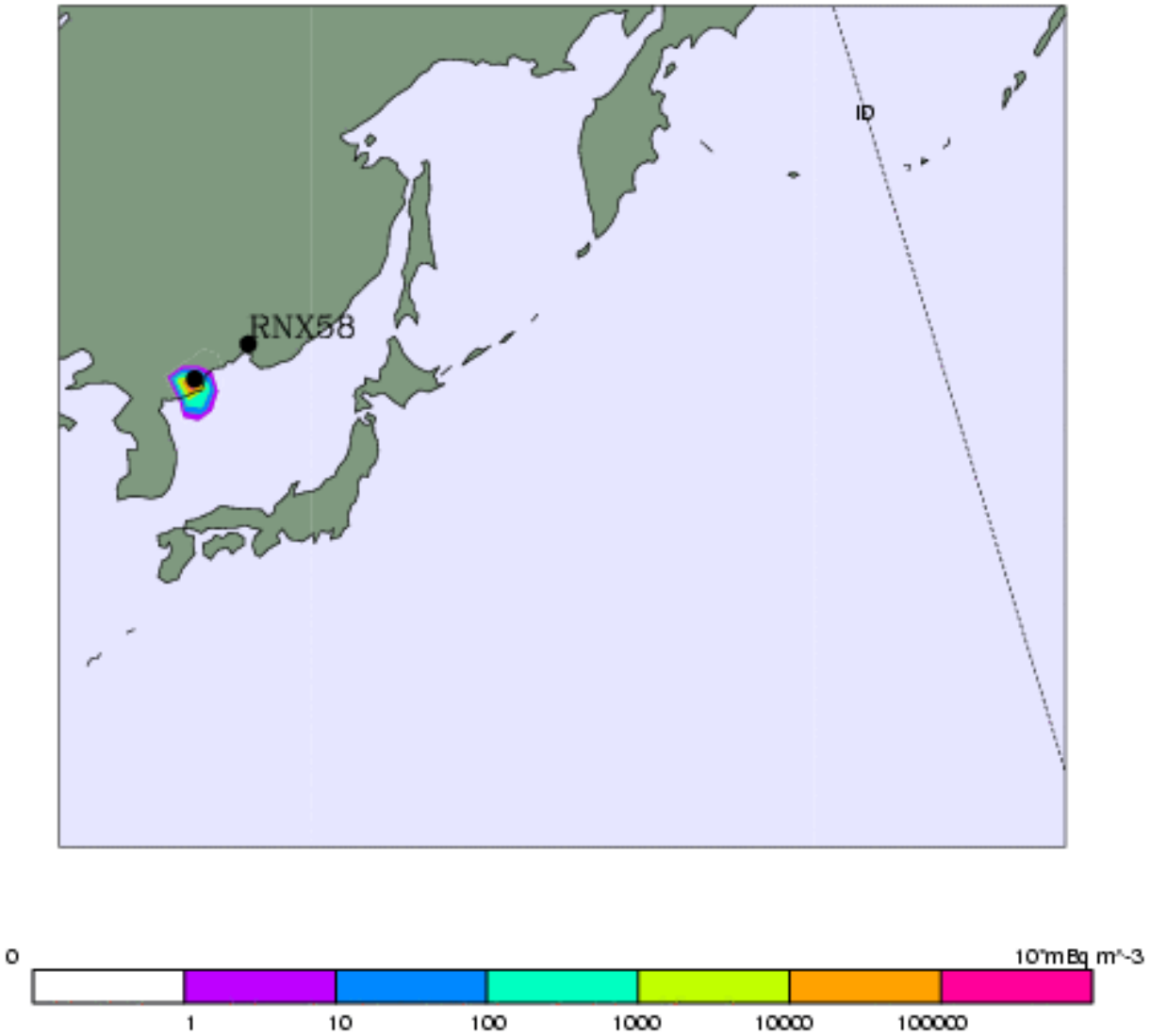

Conclusions

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- "Detector technology" is needed for nuclear proliferation / disarmament, as well as other fields
- Detector/ measurement specialist is needed by international organizations.
- Institutes are need for nuclear proliferation/ disarmament development /operation.

  →JAEA is *only* counterpart for organizations.
- Much more institutes/physicists are expected to be involved